PB-226 371

WATER SUPPLY AND WATERSHED PROTECTION

Pollution Control Council
Portland, Oregon

June 1956

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WATER SUPPLY
AND
WATERSHED PROTECTION

Pollution Control Council
Pacific Northwest Area

By
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INTRODUCTION

The purpose of this report is to point out how the use of various control measures and management practices in watersheds will conserve the water resources and prevent economic losses to municipal, industrial and agricultural water supplies, fisheries, and recreation. The report summarizes water supply and quality requirements for the various uses in the Pacific Northwest, indicates how lack of adequate control measures and management practices adversely affects these uses, and includes recommendations for improvements in watershed protection and management.

It is primarily the upper watersheds that are considered in the report. However, recommendations included for construction of roads and railroads and for agricultural activities are applicable to the lower as well as the upper portion of watersheds. Some of the watersheds in the Pacific Northwest still are in their virgin state and yield water of high quality; some have been so modified by various activities that they now yield contaminated or turbid water. Continued economic progress will necessitate extending resource developments into the upper reaches of all watersheds and utilizing more extensively the resources in presently developed areas of the Pacific Northwest. In the utilization and development of the land and water resources, Federal and State agencies and private enterprises should consider it their responsibility to: (1) preserve the excellent quality of water in presently undeveloped areas; and (2) help restore the quality of water in other areas to conditions permitting increased beneficial uses.

The first of these responsibilities requires proper planning, developing and utilizing the resources of the watershed. The control

measures and practices required usually represent only a small part of the cost of the development or income from operations. If the margin of benefit or profit in an enterprise will not withstand the cost of providing the control measures or management practices recommended, the resource development should be discouraged. Domestic water supplies obtained from properly managed watersheds in the Pacific Northwest can be purified at a cost of about one dollar per million gallons. It costs, on an average, about 40 dollars per million gallons to treat contaminated or turbid waters. Water used for many industrial purposes requires a greater degree of treatment than that used for domestic purposes. Cool, clean water is essential for growth and propagation of fish and shellfish. It is also the major recreational asset of the Pacific Northwest.

Economic considerations will govern to a great extent the ability to restore waters already damaged by various watershed activities to conditions permitting increased beneficial uses. It is economically feasible, however, to use in most cases the control measures and management practices recommended in this report. The cooperative efforts of Federal and State agencies with private enterprise will greatly facilitate this activity.

Determining the responsibility for correction of conditions that are affecting the quality of water in a watershed, may sometimes be difficult. This is particularly true in the case of abandoned mines, dumps, tailing ponds, logging operations, roads, and other structures or activities. Where territorial, state or province laws are not adequate to require the present owners of the land on which these watershed activities were conducted to correct conditions, new legislation should be proposed for early enactment.

WATER USES AFFECTED BY WATERSHED ACTIVITIES

The principal water uses damaged by various watershed activities are domestic, industrial and agricultural water supplies; swimming and other recreation; and the growth and propogation of fish, shellfish, and other aquatic life. Physical, chemical and bacterial changes in the quality of water resulting from the lack of adequate watershed control measures and management practices cause economic losses to each of these water uses.

Domestic & Industrial Water Supply -- Surface water supplies are used by more than 400 communities in supplying domestic needs for in excess of 3,000,000 people living in the Pacific Northwest. A large number of industries obtain their water for process operations and cooling purposes from the municipal systems. However, a considerable number of the larger industries obtain their water supplies directly from surface sources. The average daily surface water requirement for domestic and industrial use in the Pacific Northwest exceeds 2 billion gallons.

The important physical changes usually occuring in surface water supplies obtained from waterhseds where the control measures and management practices are not adequate are in turbidity, color, temperature, taste and odor. These effects can be corrected by a number of treatment methods, such as chemical treatment, aeration, coagulation, sedimentation and filtration. If all municipalities and those industries requiring clear water were required to remove turbidity, color, taste and odor from their water supplies, it is estimated that the additional cost of treatment in the Pacific Northwest would approximate 10 million dollars annually.

Some of the more important chemical substances which affect the quality of surface water supplies if allowed to enter streams are lead,

arsenic, selenium, hexavalent chromium, copper, iron, magnesium and zinc ions, calcium sulfates, chlorides, phenolic compounds, oil, gasoline, acids, alkalies, cyanides, and insecticides. Excessive amounts of lead, arsenic, selenium and hexavalent chromium in a water supply used for domestic and some industrial purposes are dangerous to health and prohibit the use of that supply. Excessive amounts of other chemical substances found in damaged water supplies, such as copper, iron, magnesium, zinc, cyanides, calcium and sulfates, can be removed by various treatment processes, such as aeration, filtration, chemical treatment, and ion exchange. Treatment of all surface supplies in the Pacific Northwest to remove various amounts of these chemicals and make the water usable for domestic and industrial processing purposes would cost from 5 to 10 million dollars annually. Such substances as chloride, phenolic compounds, oil, gasoline, acids, and insecticides are difficult and costly to remove from water.

Water obtained from surface sources in watersheds unaffected by activities of man is usually of excellent quality and can be used for domestic and most industrial purposes with only a minimum of treatment. Uncontrolled watershed activities may result in bacterial contamination of the water supply and require more extensive treatment. Costs of treatment are approximately one dollar per million gallons for the minimum treatment by disinfection. Polluted waters requiring more extensive treatment to include filtration and disinfection cost from 20 to 40 dollars per million gallons.

Agricultural Water Supply -- Surface waters are used to irrigate more than 4,500,000 acres of land in the Pacific Northwest. In addition, in many localities, they are the only available source of water supply for farm domestic use, stock-watering, and other agricultural uses.

The quality of water required for irrigation, stock-watering and agricultural uses other than for domestic purposes is not affected as greatly

by watershed practices as are some of the other principal uses. However, water contaminated by drainage from mines and the discharge of tailings from flotation mills may contain chemicals and minerals detrimental to the growth of some crops and unsafe for drinking by livestock. Excessive amounts of silt, algal growths and debris may clog ditches and spray nozzles, reduce the capacity of storage reservoirs, and interfere with the operation of entrance gates to canals and pumping stations, thus increasing the cost of operation and maintenance of irrigation projects.

Water is obtained from canals and stored in cisterns for domestic use by many farm families living in irrigation districts where ground water supplies are not available. This water is often used without disinfection and treatment although Public Health officials do not consider it to be a safe supply.

Swimming and Other Recreation -- Contaminated or turbid water destroys many of the recreational opportunities. Swimming in such waters is not recommended and sometimes may be prohibited by health authorities. Contaminated water requires treatment before use in swimming pools.

Water containing excessive amounts of silt, logging debris and other solids and bacterial contamination is neither safe nor suitable for fishing, boating, water skiing and other recreational uses.

Growth and Propogation of Fish, Shellfish and Other Aquatic Life -- Most fresh water fish common to the Pacific Northwest require clean water. In the Pacific Northwest there is little fishing for such species as can survive in silt laden waters.

In addition to clean water most species of fish common to the Pacific Northwest require clean gravel in which to spawn and hatch their young. It is estimated that good gravel spawning areas in a stream have an annual

value of $85,000 per acre. Many of the organisms and other aquatic life on which fingerlings and other fish feed survive only in clean water. The Hells Gate slide on the Frazier River during railroad construction in 1913 is estimated to have cost one billion dollars in fish production.

Fish that migrate from salt water and from fresh water lakes upstream to spawn can travel through moderately turbid water. However, oxygen deficiencies, petroleum products, some types of chemicals, log jams, and other debris often impede or entirely stop their progress. Fish kills have occurred from discharge of toxic substances into surface streams.

In waters where shellfish are grown for public consumption, very strict requirements exist in regard to bacterial contamination. Silt deposits from streams flowing into the tidal estuaries where shellfish are grown reduce productivity.

Water Quality Objectives -- The water quality objectives adopted by the Pollution Control Council of the Pacific Northwest states have a twofold purpose: namely, (1) to preserve in the best condition consistant with beneficial and future development those waters which have not been adversely affected by watershed developments; and (2) to restore to conditions permitting increased beneficial uses those waters which now exist at a level of quality below that which is necessary and desirable for the best interest of the people.

This twofold purpose was arrived at after thorough study and consideration of the interests of agricultural, industrial and domestic water consumers and fishery and recreational interests. Unfortunately, economic consideration does, in some cases, take preference over the interests of the domestic water consumers and other groups who might advocate the restoration of all waters to their original quality. For this reason it is not

WATER QUALITY OBJECTIVES AND M

WATER QUALITY → / WATER USES ↓	WATER QUALITY OBJECTIVES, APPLICABLE TO RECEIVING WATERS, FO WATERS				
	ORGANISMS OF THE COLIFORM GROUP	FLOATING, SUSPENDED & SETTLEABLE SOLIDS & SLUDGE DEPOSITS	TASTE OR ODOR PRODUCING SUBSTANCES	DISOLVED OXYGEN	pH
A WATER SUPPLY, DRINKING, CULINARY, & FOOD PROCESSING WITHOUT TREATMENT OTHER THAN SIMPLE DISINFECTION AND REMOVAL OF NATURALLY PRESENT IMPURITIES.	MOST PROBABLE NUMBER COLIFORM BACTERIAL CONTENT OF A REPRESENTATIVE NUMBER OF SAMPLES SHOULD AVERAGE LESS THAN 50 PER 100 ML. IN ANY MONTH	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES OR OTHER WASTES OR WHICH, AFTER REASONABLE DILUTION & MIXTURE WITH RECEIVING WATERS INTERFERE WITH THE BEST USE OF THESE WATERS FOR THE PURPOSE INDICATED	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES	GREATER THAN FIVE (5) PARTS PER MILLION EXCEPT FOR UNDERGROUND WATERS	HYDROGEN ION CONCENTRATION EXPRESSED AS pH SHOULD BE MAINTAINED BETWEEN 6.5 & 8.5
B WATER SUPPLY, DRINKING, CULINARY, & FOOD PROCESSING WITH TREATMENT EQUAL TO COAGULATION, SEDIMENTATION, FILTRATION, DISINFECTION AND ANY ADDITIONAL TREATMENT NECESSARY FOR REMOVING NATURALLY PRESENT IMPURITIES	M.P.N. COLIFORM BACTERIAL CONTENT WHEN ASSOCIATED WITH DOMESTIC SEWAGE OF A REPRESENTATIVE NUMBER OF SAMPLES SHOULD AVERAGE LESS THAN 2000 PER 100 ML. AND SHOULD NOT EXCEED THIS NUMBER IN MORE THAN 20 PER CENT OF SAMPLES EXAMINED IN ANY MONTH	SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH, AFTER REASONABLE DILUTION & MIXTURE, WILL INCREASE THE THRESHOLD ODOR NUMBER ABOVE EIGHT (8)	GREATER THAN FIVE (5) PARTS PER MILLION EXCEPT FOR UNDERGROUND WATERS	SAME AS FOR USE "A" ABOVE
C BATHING, SWIMMING AND RECREATION NOTE: WHEN WATERS ARE USED FOR RECREATIONAL PURPOSES SUCH AS FISHING & BOATING, EXCLUSIVE OF BATHING & SWIMMING, THE NUMBER "1000" MAY BE SUBSTITUTED FOR "240" IN STATEMENT OF COLIFORM OBJECTIVE	COLIFORM BACTERIAL CONTENT OF A REPRESENTATIVE NUMBER OF SAMPLES SHOULD AVERAGE LESS THAN 240 PER 100 ML. AND SHOULD NOT EXCEED THIS NUMBER IN MORE THAN 20 PER CENT OF SAMPLES EXAMINED WHEN ASSOCIATED WITH DOMESTIC SEWAGE*	SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH, AFTER REASONABLE DILUTION & MIXTURE, WILL INTERFERE WITH THE BEST USE OF THESE WATERS FOR THE PURPOSE INDICATED	GREATER THAN FIVE (5) PARTS PER MILLION	SAME AS FOR USE "A" ABOVE
D GROWTH & PROPAGATION OF FISH, SHELLFISH & OTHER AQUATIC LIFE	COLIFORM BACTERIAL CONTENT OF A REPRESENTATIVE NUMBER OF SAMPLES SHOULD NOT HAVE A MEDIAN CONCENTRATION GREATER THAN 70 PER 100 ML. IN WATERS USED FOR THE GROWTH & PROPAGATION OF SHELLFISH	SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH WILL INTERFERE WITH THE MARKETABILITY OR PROPAGATION OF RECREATIONAL OR COMMERCIAL FISH, SHELLFISH, OR OTHER EDIBLE AQUATIC FORMS	GREATER THAN SIX (6) PARTS PER MILLION	SAME AS FOR USE "A" ABOVE
E AGRICULTURAL AND INDUSTRIAL WATER SUPPLY WITHOUT TREATMENT EXCEPT FOR THE REMOVAL OF NATURAL IMPURITIES TO MEET SPECIAL QUALITY REQUIREMENTS, OTHER THAN THOSE CLASSIFIED UNDER "A" ABOVE. NOTE: TOTAL CONCENTRATION FOR CHEM. CONSTS. FOR AGRICULTURAL WATER SUPPLY, SALINITY AND SODIUM HAZARDS ARE DETERMINED BY ELECTRICAL CONDUCTIVITY (EC x 10^6) AND SODIUM ADSORPTION RATIO (SAR). WATERS HIGH IN BOTH SALINITY AND SODIUM ARE GENERALLY UNSUITABLE FOR IRRIGATION PURPOSES. (SEE "CLASSIFICATION AND USE OF IRRIGATION WATERS", CIRCULAR NO. 969, U. S. DEPARTMENT OF AGRICULTURE, NOVEMBER, 1955)		SAME AS FOR USE "A" ABOVE	NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH WILL ADVERSELY AFFECT THE MARKETABILITY OF AGRICULTURAL OR INDUSTRIAL PRODUCE	GREATER THAN THREE (3) PARTS PER MILLION	HYDROGEN ION CONCENTRATION EXPRESSED AS pH SHOULD BE MAINTAINED BETWEEN 6.0 & 9.5

* SEE NOTE UNDER C ABOVE.

Revised 12/1/56

ITY OBJECTIVES AND MINIMUM TREATMENT REQUIREMENTS

B

ICABLE TO RECEIVING WATERS, FOR SALT AND FRESH SURFACE WATERS AND UNDERGROUND WATERS							MINIMUM TREATMENT REQUIREMENTS FOR DOMESTIC SEWAGE
TASTE OR ODOR PRODUCING SUBSTANCES	DISOLVED OXYGEN	pH	TOXIC, COLORED, OR OTHER DELETERIOUS SUBSTANCES	PHENOLIC COMPOUNDS	OIL	HIGH TEMPERATURE WASTES	
NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES	GREATER THAN FIVE (5) PARTS PER MILLION EXCEPT FOR UNDERGROUND WATERS	HYDROGEN ION CONCENTRATION EXPRESSED AS pH SHOULD BE MAINTAINED BETWEEN 6.5 & 8.5	NONE ALONE OR IN COMBINATION WITH OTHER SUBSTANCES OR WASTES IN SUFFICIENT AMOUNTS OR OF SUCH NATURE AS TO MAKE RECEIVING WATER UNSAFE OR UNSUITABLE FOR USE INDICATED (U.S.P.H.S. STDS.)	LESS THAN FIVE (5) PARTS PER BILLION	NONE	NOT IN SUFFICIENT QUANTITIES ALONE OR IN COMBINATION WITH OTHER WASTES TO INTERFERE WITH THE USE INDICATED	SEDIMENTATION AND EFFECTIVE DISINFECTION
NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH, AFTER REASONABLE DILUTION & MIXURE, WILL INCREASE THE THRESHOLD ODOR NUMBER ABOVE EIGHT (8)	GREATER THAN FIVE (5) PARTS PER MILLION EXCEPT FOR UNDERGROUND WATERS	SAME AS FOR USE "A" ABOVE	SAME AS FOR USE "A" ABOVE	LESS THAN FIVE (5) PARTS PER BILLION	NONE ALONE OR IN COMBINATION WITH OTHER SUBSTANCES OR WASTES AS TO MAKE RECEIVING WATER UNFIT OR UNSAFE FOR THE USE INDICATED	SAME AS FOR USE "A" ABOVE	SEDIMENTATION AND EFFECTIVE DISINFECTION
NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH, AFTER REASONABLE DILUTION & MIXTURE, WILL INTERFERE WITH THE BEST USE OF THESE WATERS FOR THE PURPOSE INDICATED	GREATER THAN FIVE (5) PARTS PER MILLION	SAME AS FOR USE "A" ABOVE	SAME AS FOR USE "A" ABOVE	LESS THAN 25 PARTS PER BILLION OR MORE IN SUFFICIENT AMOUNTS SUCH AS TO IMPART A RESIDUAL TASTE TO RECREATIONAL OR COMMERCIAL FISH, SHELLFISH, OR OTHER AQUATIC FORMS	SAME AS FOR USE "B" ABOVE	SAME AS FOR USE "A" ABOVE	SEDIMENTATION AND EFFECTIVE DISINFECTION
NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH WILL INTERFERE WITH THE MARKETABILITY OR PROPAGATION OF RECREATIONAL OR COMMERCIAL FISH, SHELLFISH, OR OTHER EDIBLE AQUATIC FORMS	GREATER THAN SIX (6) PARTS PER MILLION	SAME AS FOR USE "A" ABOVE	NONE ALONE OR IN COMBINATION WITH OTHER SUBSTANCES OR WASTES TO SUFFICIENT AMOUNT OR OF SUCH CHARACTER AS TO MAKE RECEIVING WATERS UNSAFE OR UNSUITABLE FOR USE INDICATED	SAME AS FOR USE "C" ABOVE	SAME AS FOR USE "B" ABOVE	NONE IN SUFFICIENT QUANTITY AS TO BE INJURIOUS TO OR INTERFERE WITH THE NORMAL PROPAGATION OF FISH, SHELLFISH, OR OTHER AQUATIC LIFE	SEDIMENTATION FOR ALL USES UNDER THIS GROUP BUT DISINFECTION REQUIRED IN ADDITION ONLY IF DISCHARGED INTO WATERS USED FOR THE GROWTH & PROPAGATION OF SHELLFISH, EITHER COMMERCIAL OR RECREATIONAL
NONE ATTRIBUTABLE TO SEWAGE, INDUSTRIAL WASTES, OR OTHER WASTES WHICH WILL ADVERSELY AFFECT THE MARKETABILITY OF AGRICULTURAL OR INDUSTRIAL PRODUCE	GREATER THAN THREE (3) PARTS PER MILLION	HYDROGEN ION CONCENTRATION EXPRESSED AS pH SHOULD BE MAINTAINED BETWEEN 6.0 & 9.5	SAME AS FOR USE "A" ABOVE	NONE IN SUFFICIENT QUANTITY AS TO MAKE RECEIVING WATER UNSUITABLE FOR USE INDICATED	SAME AS FOR USE "B" ABOVE	SAME AS FOR USE "A" ABOVE	SEDIMENTATION AND EFFECTIVE DISINFECTION

always practical to restore turbid and contaminated waters to conditions which would permit use for domestic water supply without filtration and disinfection. The same is true in connection with swimming and the propagation of clean water fish. There are many streams, particularly in the lower areas, which are both turbid and contaminated. It is the policy of the Council to restore these waters to a level of quality which will permit their use for domestic and industrial water supply after treatment by filtration and disinfection, which will permit the passage of fish and which will render these waters suitable for agricultural and recreational use.

As a guide in the preservation of the good quality of water in most headwater streams and in the restoration of water in other streams to a suitable level of quality, the Pollution Control Council has adopted Water Quality Objectives shown in the attached tabulation entitled "Water Quality Objectives and Minimum Treatment Requirements".

Principal Changes in Water Caused by Various Watershed Activities -- The principal physical, chemical and bacterial changes in water which are most likely to be caused by various watershed activities are noted in the following tabulation:

Changes in Quality of Water	Construction Activities	Agriculture	Timber Harvesting & Mgt.	Grazing	Mining	Recreati
Coliform	x	x	x	x	x	x
Turbidity	x	x	x	x	x	x
Taste & Odor	x	x	x	x	x	x
Color	-	-	x	-	x	-
Mineral Sediments	-	-	-	-	x	-
Acidity	-	-	-	-	x	-
Chemical	x	x	x	-	x	-
Oil Scum	x	-	x	-	-	-
Gasoline Scum	x	-	x	-	-	-
Objectionable Solids	x	-	x	-	-	x
Temperature	x	x	x	-	x	-

Any one watershed activity possibly could cause all of the changes in the quality of water listed in the preceding table. However, only the most common effects are check marked for each of the watershed activities.

WATERSHED ACTIVITIES THAT AFFECT WATER USES

The manner in which each activity affects the water resources and the recommendations for watershed control measures and management practices are as follows:

CONSTRUCTION ACTIVITIES -- The principal construction activities that affect the quality of water are: roads and railroads, power transmission lines and dams. The polluting substances which are likely to enter streams during and after construction are silt, chemicals, oil, gasoline, litter thrown from vehicles using roadways, and wastes from construction camps and trains. Silt is frequently washed into streams from cut and fill slopes along roadways, excavations for bridge abutments, foundations for dam and tower structures, borrow pits, and from aggregate washing and handling facilities.

Chemicals used for curing and mixing with concrete and for cooling systems, and oil and gasoline occasionally are washed or accidentally spilled into streams.

Garbage, paper boxes and other articles thrown from automobiles sometimes are washed into streams thru roadside drainage ditches. They not only destroy the scenic value of the watercourse but add to the organic load carried by the river or stream.

Wastes from construction camps and railroad trains discharged into a watershed from which a domestic water supply is obtained quite often are the sources causing coliform bacteria to exceed the safe limits prescribed for use with a minimum of treatment.

1. RECOMMENDATIONS - The following recommendations cover only those phases of construction which, in the past, have been instrumental in causing serious damage to the water resources of the Pacific Northwest. Most of the public agencies and private groups responsible for construction projects have found that the control of soil erosion during and after construction pays off in reduced construction and maintenance costs. However, contractors take many short cuts which often create conditions unfavorable to the maintenance of water quality. The control measure should be adequate to assure that turbidity in the river water will not be increased to more than 10 PPM or other locally established limitation in streams used for public water supply or for salmon, trout or steelhead spawning. In streams used for other purposes, the turbidity should be kept below 50 PPM. Accordingly, specifications prepared for both public and private construction should include the following minimum requirements wherever practicable.

a. Road and Railroad Construction

(1) Location Surveys - During preliminary and final location surveys, consideration should be given to:

(a) Keeping locations away from natural drainage channels. (This refers particularly to logging and temporary access roads.)

(b) The selection of stream crossing points which will involve a minimum of disturbance to banks and existing channels.

(c) The avoidance of excessive cuts and waste dirt accumulations near natural drainages.

(2) Construction Equipment -

(a) Special precautions should be taken to prevent diesel oil, fuel oil and other substances from being washed into streams. Oil transportation facilities should make use of drip collectors, and

provisions should be made to collect and dispose of accidental spills.

(b) Drainage from construction areas should be collected and diverted away from streams. Gravel wash waters should receive adequate clarification prior to discharge to a stream.

(3) Road Bed Construction -

(a) Construction activities which cause a direct conflict with a water resource use may have to be completed at the time of least interference.

(b) Rough grading should normally be carried no further than can be completely finished during a current season. Each section graded, should be fully back sloped, have drainage installed and ditches finished before another section is opened up, particularly toward the end of the season. Dry weather construction will reduce the effects of soil disturbances.

(c) On sidehills and near channel crossings, road drainages should discharge where sediment can settle out before reaching a stream channel.

(d) Excess dirt from cuts should never be deposited directly in a flowing stream and should be kept above the high water level of the channel. End-hauling to safe bench or cove locations should be used. Waste dirt should be stabilized against erosion and slumping and should not drain directly to stream channels.

(e) Large cut slopes in critical slump areas should be graded 1 3/4 to 1 or flatter and adequate drainage measures should be installed Soil stabilization measures such as matting, terracing, compacting, mulching and planting with grass or shrubs should be used in critical areas.

(f) Large fill areas should be protected by adequate surface drainage diversion systems.

(g) On some dirt roads it will be necessary to build up the surface with rock to prevent mud and turbid waters from draining from the road bed to a nearby stream.

(h) Surface drainages from cuts and fills and from borrow and waste disposal areas should be collected in suitable ponding areas if the soils are such as to produce excessive turbidity. Drainage should be diverted or otherwise handled so as not to pass over or collect in new cuts, fills, borrow areas and waste areas.

(4) Bridges and Culverts -

(a) Bridges or culverts should be provided at all natural watercourses both for permanent and temporary access or haul roads.

(b) Culverts should be placed without excessive channel disturbance and fill materials should be kept away from culvert inlets and outlets.

(c) Permanent culvert sizes should be large enough to carry a 10 year flood and should not be less than 18 inches in diameter.

(d) Culverts should be set on the natural slope and should be extended well beyond the fill slopes. If this is not practical, head walls should be used.

(e) Large culverts should be designed in accordance with fishery department standards in order to allow for the passage of migratory fishes.

(f) The maximum spacing of culverts should be governed by the road gradient and by the type of soils, and may range from 200 feet to approximately 1200 feet.

(g) Large culvert inlets should be inspected and cleaned if necessary prior to and during the annual rainy season so as to prevent clogging and possible wash outs.

(h) Riprap or abutments should be used to stabilize fill materials or disturbed soils at bridge approaches.

(i) In domestic water supply watersheds, railroad bridges should be solid deck with drainage away from streams.

(5) Post-Construction and Maintenance -

(a) Periodic inspection should be completed on cut and fill areas to determine the effectiveness of soil erosion and stabilization measures and to determine whether or not additional precautionary measures are necessary.

(b) Drainage diversions need to be checked and maintained regularly.

b. Power Transmission Lines

(1) Specifications included in Section 1 a. above should be followed in the location, construction and maintenance of roads used for access to areas for construction and/or maintenance purposes. Roads not required after construction should be drained, mulched and seeded or planted for stabilization before being abandoned.

(2) Trees should be removed from the area by approved logging methods as specified in Section 3 c. following. Land from which trees and other vegetation is removed should be seeded or planted with a type of vegetation which will not interfere with the overhead lines but which will stabilize the soil.

(3) Soil excavated for tower footings should be placed so that it will not be washed into the stream during storms and should be leveled so that all disturbed areas can be seeded upon completion of construction.

c. Dams

(1) Overburden removed from borrow pits should be placed in such a manner as to minimize the washing of excavated materials into the

watercourse during rainy periods. Where necessary to pump or drain water from the excavated area, it should be disposed of by spreading on soil covered by vegetation or by other means which will limit the amount of the turbid water raching the watercourse. Before abandoning borrow pits located outside the reservoir area all soil in the spoils banks should be replaced in the excavated area, smoothed and stabilized by seeding or other means.

(2) If at all possible, sand and gravel or stone for crushing should be obtained from areas other than the stream bed itself. Where necessary to obtain aggregate from the bed of the stream, the section or sections being worked should be dammed off or secured in accordance with territorial, state, or provincial regulations where applicable. Before any wash water is discharged, it should be clarified sufficiently to assure that turbidity in the river water will not be increased to more than 10 parts per million or other locally established limitation in streams used for public water supply or for salmon, trout or steelhead spawning. In streams used for other purposes, the turbidity should be kept below 50 PPM for normal stream flow. A closed system wherein none of the wash water is discharged to a stream is preferred. Where wash water is to be discharged to a stream, suspended wastes should be removed by impounding, coagulation and sedimentation, or other acceptable methods which will meet the above criteria.

(3) Tanks and container areas used to store fuel, oils, chemicals and toxic substances should be protected from leakage by construction of dikes around the tanks to catch any liquid losses.

(4) Concrete and aggregate plants should be inspected frequently to assure that wastes will not accumulate in locations where drainage to the watercourse cannot be controlled.

(5) Specifications included in Section 1 a. above should be

followed in the relocation of roads and railroads and construction and maintenance of access roads.

(6) Specifications included in Section 3 c. following should be followed in clearing of reservoir areas.

d. Construction Camps and Crews

(1) Definition: Construction camps are considered to be facilities providing housing and feeding for personnel and serving for the duration of a specific construction activity. Equipment maintenance and office facilities are sometimes provided at the same or other locations. Construction and maintenance crews working in watersheds are those transported to the point of work from a central camp or headquarters.

(2) Location: Where the construction activity is on a domest water supply watershed yielding high quality water requiring no treatment, except disinfection, the construction camp should be located completely out of the watershed, unless over-riding factors can be shown to dictate otherwise. When they must be on the watershed, domestic or otherwise, they should be located as remotely as possible from the main stream and any of its tributaries so as to eliminate or minimize any effect upon the water. They should be located on land having topography which will have a minimum of erosion due to rainfall and snow melt.

(3) Approvals: Any installation, operation and methods of sanitary waste disposal facilities should meet the requirements of and be approved by the health department having jurisdiction and by the owners of the water supply if involved.

(4) Facilities for Waste Disposal:

(a) For use on Domestic water supply watersheds yielding high quality water requiring no treatment except disinfection.

1. Body waste. Provide portable waste containers for disposal outside of watershed at a point approved by appropriate local jurisdiction. This type consists of containers such as oil drums which should be removed from the watershed as necessary and the drum and contents buried or the drum cleaned and contents buried. Reusable tops equipped with seats and self-closing covers are preferred. Chemicals for odor and fly control will be desirable. At the point of disposal by burial, a disinfectant may be necessary as required by local authority.

2. Garbage and other Refuse. All garbage and other refuse should be stored in covered, sanitary, waterproof, metal containers except that dry refuse, such as clean paper cartons, may be neatly stored separately. Containers and the area of storage should be so located and kept clean to minimize fly population, odors and rodents. The contents should be removed at frequent intervals from the watershed to an approved point of burial or for pick-up by commercial haulers. At an approved point of burial, use tranch and fill or other sanitary fill method, compact the material and cover with a minimum of 18 inches compacted fill dirt daily. Dry refuse should be removed from the watershed regularly, buried within the watershed at an acceptable point of disposal, or incinerated if fire regulations permit.

3. Clean-up. During the construction period and at final clean-up all areas occupied should be policed regularly for wastes and refuse. At points of burial finished surfaces over compacted fills should be shaped and treated to prevent ponding and erosion. The entire occupied area should be maintained and kept in a clean condition.

4. Pit privies, water-carried waste systems, and burial of body wastes and garbage should not be permitted on this type watershed.

(b) For use on watersheds not used for domestic supply or where pre-existing conditions already require filtration and disinfection for domestic use.

1. Body Waste. Portable waste containers or sanitary pit privies for small construction camps and crews in upper watersheds should be used. Extreme care must be taken in selecting the point of burial and location of privies. They should be located remotely from any watercourse and on topography not subject to flood, high water table or to erosion from rainfall and snow melt. Avoid loose (sand and gravel) formation where rapid leaching to a watercourse could occur. Use chemicals for disinfection and fly and odor control. When abandoning pit privies, disinfect the contents of the vault and cover with compacted fill.

For larger construction camps, except in upper watershed as discussed previously, water-carried waste systems may be used. The installation of a sub-surface disposal field, for use with septic tanks, should be at a location remote from any watercourse, on relatively flat ground without high water table, free from flooding or erosion by rainfall and snow melt, and having adequate absorption capacity to receive the effluent without rapid percolation to a watercourse. In lower watersheds where treatment and discharge to streams is acceptable, refer to the appropriate pollution control authority for determination of degree of treatment and final approval.

2. Garbage and Other Refuse. Garbage and other refuse should be disposed of by sanitary fill method at an approved location or by arrangement with commercial haulers. The location for a sanitary fill should be remote from any watercourse and on land free from flooding, high water table or erosion from rainfall and snow melt. The particular method

of burial should be suitable to the particular site, but in any event the material should be compacted and covered with a minimum of 18 inches compacted fill dirt daily. Liquid wastes from the kitchen and from bath and shower water should be held to a minimum where subsurface disposal is used.

3. Clean-up. During the construction period and at final clean-up, all areas occupied shall be policed regularly for waste and refuse. At points of burial finished surfaces over compacted fills should be shaped and treated to prevent ponding and erosion. The entire occupied area should be maintained and left in a clean manner.

e. Railroad Trains in Watersheds.

(1) The discharge of wastes from railroad trains is a problem which is particularly acute on domestic water supply watersheds. The modern train, with private compartments and toilets renders any requirement of non-use of facilities while passing through the watershed impractical of complete compliance. Although the railroad industry, through its Joint Committee on Railroad Sanitation, has done considerable research and development work on means of solving this problem, no specific methods have been put into large scale practice. By comparison, the airline industry has found and applied a satisfactory method by the use of retention tanks on aircraft which are discharged and serviced at the air terminals. The U. S. Public Health Service regulations for Land and Air Conveyances Operating in Interstate Traffic require that there shall be no discharge from any land or air conveyance of fecal waste, garbage, waste water, or other polluting materials while any such conveyance is passing through or over any city or town, a public water supply watershed, the vicinity of a water supply intake in a lake or river, a reservoir from which water supply is derived, or an approved area from which shellfish for domestic consumption are obtained. An attempt at

compliance with this requirement includes the locking of common toilet facilities, and informing the patrons and seeking their better judgment in the use of the facilities while passing through the watershed. Obviously, 100 per cent compliance is not obtained. Even if 100 per cent non-use of the facilities while passing through the watershed could be obtained, the problem would not be completely solved. Observers have noted during the winter months that trains passing west over the Cascade Range will carry frozen fecal matter and other wastes on the under parts of the railroad cars and that after descent into lower elevations and warmer temperatures the materials thaw and drop off the train. Bridges have been flashed in an attempt to protect streams but the flashing will corrode unless adequately protected; also train snow plows will push the accumulated material with snow directly into the stream.

(2) For the immediate future, the following requirements should be met by railroads on public water supply watersheds.

(a) Locking of all toilet facilities while passing through the watershed. (Trains on the Seattle watershed have been required to inform the patrons by public address system just prior to entering the watershed and install mechanical locks for all compartment toilet facilities. These can be operated by train personnel from the train corridor.)

(b) Hold all kitchen wastes and other refuse for discharge at terminals.

(c) Periodic inspection of the railroad right-of-way to determine compliance with the above requirements. (In the Seattle watershed policing of the railroad right-of-way by railroad and water personnel immediately after the passing of each train and the removal of all fecal and other solid waste material for disposal at a suitable point is required.)

(3) The ultimate solution would seem to be the installation of suitable retention tanks for discharge and servicing at railroad terminals

AGRICULTURE -- The principal agricultural activities that affect the quality of water are: feeding and watering of livestock; cultivating of land irrigation; spreading of insecticides; and disposal of domestic and livestock wastes. The polluting substances which are likely to enter watercourses from these activities are silt washed into the stream from eroding farm lands, and from stock watering and feeding areas, chemicals washed into the stream from fertilizers applied to soil or leached from the soil in irrigating crops and reaching the watercourse thru return flow channels, and domestic and livestock wastes reaching the watercourse thru drainage channels. Dusts and sprays to control insects and plant diseases sometimes are carried down to streams. Higher temperature waters are likely to result from excessive amounts of irrigation return flows.

2. RECOMMENDATIONS - The following are recommended practices for the protection of watersheds from agricultural activities:

a. Feeding and Watering of Livestock

(1) Feed lots should be located on level ground or drainage from them directed to absorption areas. Covered feed lots with facilities for storing manure until it can be spread on the field is ideal. Drainage of lots into streams or locating them near streams is objectionable.

(2) Livestock watering places should be located away from streams where possible. Where they are located on streams controlled areas to the stream or watering facility should be provided. Such controlled access should provide for the least disturbance to the stream and its banks. Streams can be completely fenced except for planned access to water.

b. Cultivating Land

(1) Since Federal and State agencies have been established for the specific purpose of conserving soil and moisture on farm lands it does not appear to be within the scope of this report to recommend practices for erosion control. It should be pointed out, however, that silt which reaches streams from eroding farm lands is a major cause of high turbidities in waters of the Pacific Northwest. By cooperation with the Soil Conservation Service, Agricultural Conservation Program Service, State Extension Services, and Soil Conservation Districts, farmers can help reduce this serious erosion problem and help maintain the excellent quality of water in streams of the Pacific Northwest.

(2) Fertilizers when applied on saturated soils or when flood conditions may be a hazard are lost to the stream by runoff. This can be controlled by timely applications.

(3) Certain chemicals, like fertilizer, may be washed from the vegetation and soil, and enter stream runoff. Care should be exercised in applying chemical sprays and dusts where they may fall on water surfaces or be washed into streams.

c. Irrigation

(1) Chemicals leached from the soil and reaching streams thru return flow channels can and should be controlled. The amount of return flow from the land should be controlled by use of improved irrigation methods for reducing the amount of water applied to the land.

(2) Irrigation water should be applied only as needed to maintain a high state of crop production. Amounts to apply should only replace the moisture in the root zone of the plants being grown. This can be accomplished by the use of any method of application if the system is

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properly designed and good water application practices are followed. Sprinkler irrigation is especially efficient in the use of water.

d. Livestock Wastes

(1) Manure is an ideal fertilizer when preserved and not allowed to leach away before it is applied or after application to the land.

(2) The best way to conserve manure is to store it out of the weather in a manure shed until it can be spread. This will avoid leaching of plant food into runoff and stream channels.

(3) Avoid spreading on very wet or frozen ground.

(4) Spread manure when it can be worked into the soil or during the growing season.

(5) Manure piles during warm weather are breeders of flys. Therefore, schedules should be established for spreading manure on grass land during the summer and fall months and for storing in piles during the winter months for spreading on cultivated land after the spring rains.

(6) Dead animals should either be buried or taken to a rendering plant for disposal.

e. Domestic Wastes

(1) Septic tanks and subsurface disposal systems or seepage pits should be used for disposal of domestic sewage. All such facilities should be designed and constructed in accordance with the requirements of the Health Department having jurisdiction.

(2) Garbage and other household wastes should be buried or burned but in no case disposed of in drainage ditches or watercourses.

TIMBER HARVESTING & MANAGEMENT -- Logging operations and fires are primarily responsible for the original declines in the quality of water. Until the forest vegetation is removed most watersheds produce clean water.

It is in such virgin areas that a great number of the public water supplies of the Pacific Northwest have their source. Unless the utmost care is taken in planning and in the location and construction of logging roads, and in logging operations, declines in the quality of water will extend upstream to headwater sources as logging activities continue into the higher forested area.

The principal polluting substances which are likely to enter watercourses from timber harvesting and management activities are silt, logs, brush, decayed vegetation, insecticides, cinders, oil, gasoline, and logging camp wastes.

Silt is frequently washed into streams from poorly located or constructed roads, skid trails, dragging logs across stream channels, burned-over areas, and a number of other operations.

Logs and brush enter watercourses through carelessness in felling trees, cleaning up and disposal of brush.

Decayed vegetation enters watercourses if disturbed in logging operations and left to be washed into the stream during rainstorms.

Cinders are frequently washed into streams from burned over areas.

Oil and gasoline are likely to be washed into streams if equipment operators are careless in handling fuels and lubricants and disposing of used oil.

Garbage refuse and untreated domestic sewage from logging camps sometimes drains or is discharged into streams.

Dusts and sprays used to control diseases, also are sometimes carried down to streams.

3. RECOMMENDATIONS -

a. Access Roads - Specifications included in Section 1 a. above

should be followed in the location, construction and maintenance of roads used for access to forest areas.

b. Spur Roads -

(1) Spur roads used for hauling logs from cutting areas should be located as closely as possible on contour with side ditches provided to carry water to spreading areas. Ditch water should be diverted at frequent intervals on to areas where it can settle out before reaching stream channels.

(2) Construction should take place only during dry weather.

(3) Upon completion of the logging operations in an area, all spur roads should be leveled off by filling side ditches and restoring disturbed soil to its original contour. The disturbed area should either be seeded or covered over and secured with a layer of mulch prior to abandonment.

c. Logging -

(1) Provisions to protect the water resource must be included during the initial stages of logging management planning and must be followed continuously until logging operations have been completed.

(2) The location of cutting areas and the location of road networks should be correlated in such a manner as to minimize disturbance to the terrain. Cutting boundaries, landings and spur roads can thus be laid out in accordance with the conditions of topography, soil types, and climatic factors in order to take into account the effects of snow accumulations and melt, and to handle drainage so that muddy and turbid waters will be kept out of stream channels.

(3) The methods of yarding and the equipment used may exert adverse influences on the water resource. Depending on topography and soil

condition and type, high-lead cable yarding uphill is usually preferable from the standpoint of protecting stream banks and channels. Tractor yarding should, if possible, be limited to terrains of less than 15 percent slope in heavy and erodible soils, and should not be used at all on heavy clay soil during wet seasons, on saturated ground, or generally on slopes in excess of 30 percent.

(4) Only a few turns should be brought in over each skid trail so as to avoid deep gouging, compaction, and channelizing.

(5) Skid trails should never run in channels or down channel banks. Channel crossings should be as few as possible and on temporary culverts.

(6) Where it is not possible to lift logs across stream channels with a slack line, temporary measures such as log or metal culverts should be used to prevent excessive conditions of turbidity and scouring of the stream banks.

(7) Landings should not be located adjacent to channels. Logging debris must be removed from stream channels.

(8) Skid trails should be drained so as to divert water away from landings. It is imperative that cross drains or water-bars be installed in the steep abandoned skid trails and spur roads so as to divert drainage concentrations and prevent severe erosion.

(9) Seeding of landings and skid trails to grasses and legumes is favored in the Ponderosa Pine and mixed species types east of the Cascades. For Douglas Fir and other types west of the Cascades, seeding or planting of landings and skid trails to forest species is favored.

(10) When logging near streams, trees should be felled uphill away from channels, and slash and debris should be kept out of the watercourse

(11) Steep pitches and shallow soil areas immediately adjacent to stream channels should not be logged.

(12) Buffer strips at least 30 feet wide should be left along channel edges except in special instances where stream banks are subject to under cutting and sliding.

d. Logging Camps and Crews

(1) Logging camps are considered in the same category as construction camps. Due to better access roads and transportation, there is a greater trend in present times toward transporting crews in and out of logging areas each day. This is desirable from a watershed sanitation standpoint and is recommended as regular practice.

(2) When it is absolutely necessary to maintain camps the same sanitation practices as outlined under Construction Activities (Section 1 d. above) are to apply. Likewise, the sanitation practices for logging crews shall be the same as outlined under Construction Activities.

(3) Full cooperation with local health authorities and the owner of the water supply affected is essential together with constant vigilance in discipline of the crews in use of the facilities.

e. Forest Fire Control and Prevention

(1) Adequate fire prevention and control measures are of major importance since fire is a constant threat to the timber and water resources of a forested watershed. The low annual burned over area (about one-twentieth of one percent of total forest area) in favorable years indicates a very effective resource protective program which should be maintained.

(2) The burning of slash has at times had adverse effect on the waters of domestic water supply watersheds. In areas of heavy burning the soil may be exposed to accelerated erosion. Surface drainages may carry

increased color and ash and turbidity for several years or more after burning. These adverse influences and the trend for increased timber utilization may ultimately reduce the need for widespread burning as a means of slash disposal. A number of timber companies are now utilizing slash in producing saleable products.

(3) On several water supply watersheds management practices are being developed to eliminate alder trees along streams since the leaves of these species tend to influence color and perhaps water taste. Insect larvae on leaves that drop into streams and affect water quality can be controlled by removing their preferred food plants (alders, willows, shrubs, etc.)

GRAZING -- Grazing is important to watershed protection because of certain dangers inherent in improperly controlled grazing. One is the danger of pollution of water supplies from animal droppings and dead animal carcasses. Another is the danger of increased turbidity and sediment from erosion of watershed slopes damaged by too heavy grazing.

There are various ways to combat these hazards. The simplest is to close watersheds to grazing. However, with increased pressures for multiple use on most wild lands, the desirability of closure may be questionable. Further, the expense of fencing may provide a serious objection to closure. If the forage can safely be used, it should be used.

The pollutional substances which may enter streams from grazing lands are silt and livestock wastes.

4. RECOMMENDATIONS -

a. Provision of watering troughs, guard fences, and masonry casings at springs and seeps will prevent trampling and fouling of the water and keep silt from draining off to the nearest stream.

b. Holding domestic stock off ranges where the soil is still wet with snowmelt and the cover vegetation is undeveloped will prevent excessive soil compaction. Compacted soil does not take up moisture readily nor does it provide good conditions for plant growth. Rapid runoff of rainwater and snow-melt from areas of compacted soil may lead to flash floods, severe erosion, silted stream channels, and turbid waters.

c. A similar problem exists with big game, particularly elk. Large herds following the retreating snow line in spring do extensive damage to the soil and overgraze oncoming new plant growth. Control of game may be accomplished by special hunts to reduce herd size. Planting to grow adequate supplies of succulent feed elsewhere may also help.

d. Sufficient restrictions on grazing in domestic supply watersheds may be gained by fencing off stream channels to keep stock from fouling the water or from breaking down channel banks. Where stock are managed by herders, they can be kept to the benches and upper slopes away from streams.

e. To preserve favorable conditions for absorption of surface water, prevention of soil erosion, and continued production of forage various measures may be adopted. Increasing range area from the watershed may reduce grazing pressures on the watershed. Increasing the amount and quality of the forage by seeding and planting desirable species of grass and shrubs may also help. Improvement of the cover, whether from the forage standpoint or for watershed purposes, probably will require reductions of grazing use at least temporarily. To maintain gains made will require careful management of grazing use thereafter.

f. Many watershed lands have greatly deteriorated from the effects of continued overgrazing many years ago. The topsoil is gone, leaving a stony and rather impervious clayey subsoil. Plant cover is sparse. These areas are most common on ridgetops and upper slopes. Runoff from them

is flashy, and causes serious gully and channel erosion below. Rehabilitation is a costly and time-consuming job, but it is possible. It includes seeding to grass and herbs, and planting to shrubs. To prepare the site to take seed, absorb moisture, and afford even fair habitat for growing plants first requires cultivation of the soil. After seeding, mulching to provide shade, to give physical protection against sun and wind and rain, and to furnish organic litter is also often necessary. Finally, fencing to keep stock and game out for several years is required.

g. Dead animal carcasses should either be buried or taken to a rendering plant for disposal.

MINING AND PROCESSING OF ORES -- The mining and processing of ores can cause greater effect on the water resources than any other watershed activity. Uncontrolled mining and ore processing can render a stream unfit for most water uses. Mines which have been worked and abandoned and abandoned access roads can also cause damage to the water resources. The principal activities that affect the quality of water are: Construction and maintenance of roads, strip mining, underground mining and ore processing plants. The pollutional substances which are likely to enter streams from these operations are: silt, color, minerals, acids, and chemicals.

Silt is frequently washed into streams from poorly constructed and maintained roads, strip mining disposal areas, hillside diggings, tailings dumps, ore crushers, and ore processing plants.

Minerals, such as lead, zinc, iron, cyanides, and other types, are sometimes discharged or washed into streams from tailings dumps, mines, coal washing and ore processing plants.

Acids or other chemicals are sometimes discharged or washed into streams from tailings dumps, abandoned and active mines, coal washing and

ore processing plants.

High temperature liquid wastes are sometimes discharged into streams from abandoned and active mines and settling basins.

5. RECOMMENDATIONS--

a. Road Construction - Specifications included in Section 1 a. above should be followed in the location, construction and maintenance of roads used for access to mines and mining areas. Roads not required after mining operations are discontinued should be drained, mulched and seeded or planted for stabilization before being abandoned.

b. Abandoned Mines

(1) Responsibility for cleaning up and protecting areas disturbed during mining operations is that of the owner. The party or parties filing a claim to mineral rights on federal lands do not receive a "patent" or ownership title to the land until a certain amount of mining has been carried out and the mineral content of the ores prove sufficiently valuable to continue operations. These parties, however, are owners of the mineral rights and all structures built within the claim. Accordingly, they are responsible, as owners, for any conditions created which affect downstream water uses and are subject to state regulations through the concurrent jurisdiction provisions relating to Federal lands under constitutional law. Some of the states in the Pacific Northwest have laws and regulations governing the abandonment of mines. Unfortunately, however, these laws and regulations were not in effect when some of the early mines were abandoned and enforcement has not always been successful in eliminating drainage from mines and dumps more recently abandoned. Drainage from abandoned mines and dumps should and can be kept out of watercourses or its harmful effects can be controlled. Before abandoning a strip mine all overburden should be

placed back in the area from which it was removed and covered with a layer of the original or new top soil. This area should then be seeded with an approved vegetative cover. All openings into underground mines should be sealed in such a manner that will assure that no drainage will come directly from the mine after it is filled with water.

c. Active Mines - Owners of mining claims and owners of land on which mining operations are or are to be undertaken should include in their operation plans or leases the following specifications for control of pollution.

(1) Dredge or Placer Mining --

(a) No operations should be allowed in the beds of streams unless the area being worked is dammed off.

(b) Settling ponds should be constructed to impound and clarify all water used in the mining process before it is returned to the stream. Where possible a closed system, wherein no process water is returned to the stream should be used. This should apply to both operations on land and in the bed of streams. Before discharging any impounded water to the stream, it should be clarified sufficiently to assure that the turbidity will not be increased to more than 10 parts per million or other locally established limitation in streams used for public water supply or for salmon, trout or steelhead spawning. In streams used for other purposes, the turbidity should be kept below 50 parts per million for normal flows.

(c) Before starting an operation on land, all top soil should be removed and piled in a convenient location. All ground disturbed during the mining operations should be smoothed over comparable to the natural contour of the ground prior to disturbance. The top soil removed from the area should be placed on top of the disturbed area and

after smoothing, seeded with an approved vegetative cover.

(d) Ground disturbed in the beds of streams should be replaced on meander lines with pool structure conducive to good fish and wildlife habitat and recreational use.

(2) Strip Mining --

(a) Prior to the start of a strip mining operation all top soil should be removed from the area and placed in a convenient location for future use.

(b) All overburden removed from the area should be placed separately from the top soil in locations where none of the soil will be washed into streams during rains.

(c) During mining operations all water removed from the depression should be pumped to impoundments or allowed to spread on areas covered with vegetation. In no case should any of this water be discharged to the stream directly.

(d) Upon completion of the mining operations, all overburden removed should be spread over the area worked, upon which a layer of top soil should be placed. The entire area should be seeded with an approved vegetative cover.

(e) In a number of locations in the Pacific Northwest, particularly the side slopes in narrow canyons, it may be impossible to place the top soil and overburden where it can be returned to the stripped area after removing the ores. In these instances the plan of operation should be submitted to the pollution control agency for approval prior to the start of any such workings.

(3) Underground Mining --

(a) Openings to underground mines should be diked off

or otherwise protected to assure that drainage from the mine and working or dump areas near the opening will not flow into streams.

(b) All drainage and process water used in the operation will be clarified prior to discharge sufficiently to assure that the turbidity will not be increased to more than 10 parts per million in streams used for public water supply or for salmon, trout or steelhead spawning. In streams used for other purposes the turbidity should be kept below 50 parts per million for normal flows. Drainage water containing chemicals in amounts harmful to any water use should be treated to remove harmful chemicals prior to discharge to a watercourse.

(4) Coal and Ore Processing --

(a) Coal and ore processing mills should be located as far away as possible from watercourses and in areas with sufficient land for lagooning or storage of waste tailings. In no case should mills be located where it is necessary to store waste tailings in or immediately adjacent to streams.

(b) Areas used for storage of crushed ore or chemicals used in processing should be surrounded with a dike or housed in water tight structures. Water impounded back of the dike should not be allowed to drain into the watercourse.

(c) Waste process water containing fines and tailings from ore concentration, separation and flotation mills and coal washers should be discharged to settling basins or impoundments. After sedimentation, water flowing from the settling basins should be further treated by filtration or by other means if necessary to remove chemicals harmful to any water use or to assure that the turbidity will not be increased to more than 10 parts per million or other locally established limitation

in streams used for public water supply or for salmon, trout or steelhead spawning. In streams used for other purposes the turbidity should be kept below 50 parts per million for normal flows.

(d) Waste tailings removed from settling basins and other dump materials should be placed in areas completely surrounded by a dike or returned to the mine. Drainage water collected back of the dike should not be discharged to the watercourse if it is turbid or contains chemicals harmful to any water uses.

(e) Other type ore processing mills should be equipped with treatment facilities of adequate capacities and of types approved for removal of suspended solids, toxic chemicals, or radio activity from waste waters. Included in this category are ore precipitation plants, and plants for the extraction of aluminum oxide and uranium compounds.

d. Mining Camp Sanitation - The same principles of sanitation apply to mining camps as are outlined under sanitation for Construction Activities (Section 1. d.). Permanent camps should not be located on domestic water supply waterhseds yielding high quality water requiring no treatment except chlorination.

RECREATION -- The development and maintenance of recreational areas is the responsibility of a number of Federal and State agencies and private groups. The principal activities which can affect the quality of surface waters are: construction of roads, buildings, parking areas, picnic areas and camp grounds, and drainage facilities; disposal of wastes and location of tent camps. The polluting substances resulting from these activities are silt washed into streams during construction and improper maintenance of roads, buildings, parking areas, and garbage, refuse, litter, and untreated domestic sewage discharged or drained into streams from hotels, cabins,

picnic areas and camp grounds.

6. RECOMMENDATION --

a. Permanent Construction - Permanent camps with permanent buildings, access and facilities provided by governmental agencies or private industry.

(1) Roads: The construction of roads for any purpose poses the same problems. The principles of road building in watershed for recreational access should be the same as outlined for Roads and Railroads under Construction Activities (Section 1. a.). Where a domestic water supply is involved the area should be so posted at adequate intervals. Where travel time is particularly long, sanitary pit privies of durable construction located at convenient intervals and remote from watercourses should be provided and maintained by responsible authority.

(2) Buildings: Buildings should be of durable construction, designed and operated in accordance with good sanitation practice. The location of the building should be such that no adverse effect on the stream will result from sanitary facilities provided.

Design and maintenance should be such as to minimize fire hazard. Bulk fuel oil and gas storage should be separate from buildings for other purposes and where large quantities are involved, emergency catchment basins should be provided to counteract accidental spillage and spread of fire.

(3) Parking Areas: Parking areas for camps and view points should be located in accordance with principles outlined under Construction Activities (Section 1. a. above). View points should be located preferably 100 yards from domestic water supply streams yielding high quality water requiring no treatment except disinfection. Convenient covered containers of

durable construction for refuse should be provided and maintained by the responsible authority. When sanitary facilities are provided they should be constructed and maintained as outlined under Construction Activities (Section 1. d. above).

(4) Picnic Grounds: Picnic grounds should be prohibited on domestic water supply watersheds yielding high quality water requiring no treatment except disinfection. Construction of cooking facilities, parking areas, and sanitation facilities should follow the principles and objectives outlined under Construction Activities (Section 1. a. above). Facilities for disposal of garbage, refuse and domestic sewage should be designed, constructed, and maintained as outlined under Construction Activities (Section 1. d. above).

(5) Overnight Camps: Overnight camps should be prohibited on domestic water supply watersheds yielding high quality water requiring no treatment except disinfection. Construction of overnight camps should follow the principles and objectives outlined under Construction Activities (Section 1. a. above) giving particular attention to minimizing fire hazard, erosion, insanitary conditions and adverse effect on streams. Sanitary facilities provided should be simple, durable and well maintained. Water carriage waste systems should be designed and operated to use a minimum amount of water for disposal. Well maintained portable facilities or sanitary pit privies are preferable where conditions are not suitable for subsurface disposal. Refer to sanitation practices under Construction Activities (Section 1. d. above) for detailed principles.

b. Temporary Tent Camps -

(1) Temporary tent camps should be prohibited on domestic water supply watersheds yielding high quality water requiring no treatment except disinfection.

(2) Follow same construction principles outlined under Overnight Camps for Permanent Construction. Use portable sanitary facilities or sanitary pit privies of durable construction. Avoid use of water carriage waste systems, otherwise follow sanitation principles outlined under Construction Activities (Section 1. d. above).

c. Swimming - Swimming and bathing in streams on public water supply watersheds yielding high quality water requiring no treatment except disinfection should be prohibited. On other streams, sites for recreational swimming should be located where adequate sanitary facilities for the use of the public and the protection of the stream can be installed.

d. Hunting and Fishing - Hunting and fishing on public water supply watersheds yielding high quality water requiring no treatment except disinfection should be prohibited. Under certain conditions where damage is being inflicted by an over-population of game animals, special hunts can be arranged. The cooperation of health, game and city officials and the hunters is essential to a successful program. Where the problems of over-population justifies the special hunt, hunting should be allowed only by special permit and the hunters should be advised in writing as to the nature of the watershed and instructed as to conduct on the watershed with particular emphasis on the proper disposal of garbage, offal, blood, urine, fecal matter and refuse. Overnight camping on the watershed in connection with these special hunts should be prohibited.